City College of New York **Department of Civil Engineering**
CE 36500 - Hydrology and Hydraulics Engineering

Experiment 7

Outfall Diffuser

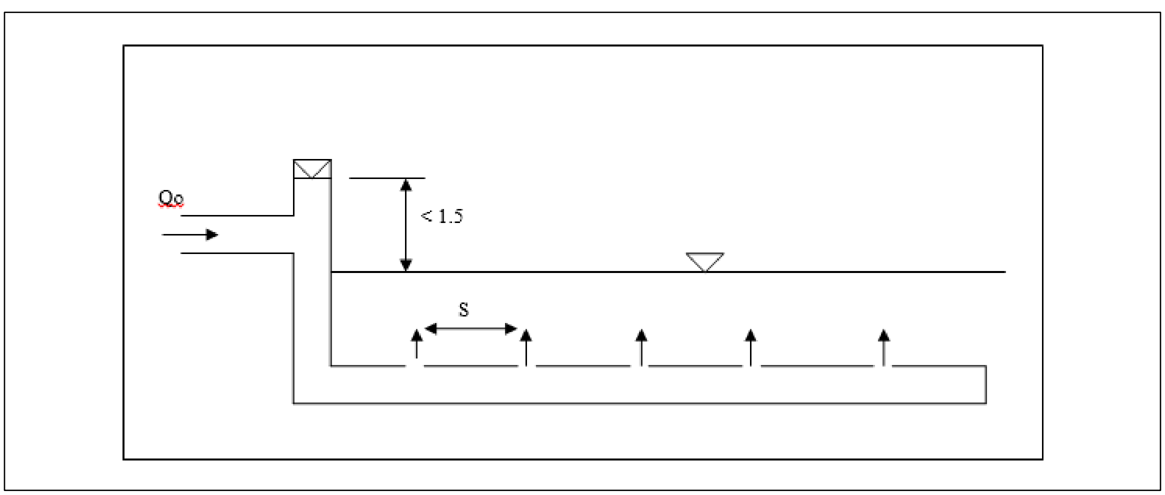
Objectives:

- Use fundamental hydraulics principles and equations to compute flows in a device, the "Diffuser", that Waste Water Treatment Plants often use to better disperse effluent loads across the stream width and thus aiding better stream mixing of these flows
- Apply your knowledge from class and apply it to a problem NOT explicitly covered in class. Use computational tools to tackle this task allowing you to apply your analytical skills in addition to improving (or learning new ones) computational skill sets.

Background:

In general, it is possible to specify the desired flow distribution in a multi-port distribution system and to solve for the required flow areas to achieve this distribution provided that the upstream energy in the system is known. However, for a diffuser, a range of discharges may be experienced and the upstream energy level is likely to be a variable as well. In addition, the construction of different sized orifices at each discharge point is generally not feasible from an economic point of view. Therefore, it is generally better to specify a given diameter for all the discharge orifices or at least a combination of only a few different orifice diameters and then to compute the flow distribution from the proposed system.

Set up:



Experimental Procedure

Prepare a computer program or spreadsheet, which calculates the distribution of flow in a diffuser pipeline. The following design parameters will be used in the analysis:

design discharge:	Q_o	Diffuser diameter:	DIA
# of orifices:	N	Spacing between Orif.:	S
Diffuser pipe friction:	F		

Discharge coefficient for orifice: $$c_d = 0.63 - 0.58\frac{v^2}{2gE}$$

in which v is the velocity (in the pipe) just upstream from the orifice and E is the difference between the total energy inside the pipeline and the static head outside.

The analysis should begin with an assumed energy head at the upstream end of the diffuser and proceed downstream with repeated applications of orifice and energy equations. The repeated calculations will include the following steps:

1. Calculation of the orifice c_d based on local conditions.
2. Calculation of orifice flow, $Q_i = c_d A_i \sqrt{2gE}$.
3. Calculation of velocity in the pipe downstream from the orifice.
4. Calculation of the friction loss to the next orifice.
5. Calculation of the velocity head and energy at the next downstream orifice.

The repeated calculations will yield a total orifice discharge associated with the assumed upstream energy. Adjustments in this energy will then be necessary until the computed discharge agrees with the design discharge, while satisfying the following constraints:

1. The flow rates from the orifices must be within 7% of each other.
2. At the design discharge, the available head at the upstream end of the manifold cannot exceed a specific value.

Questions:

Prepare a brief description of the computations including a description of the input and output. Details of the computations must be submitted with the attached output to show your solution. The output must include the orifice diameters and the flow distribution from the orifices. Also, provide a listing of the required energy head at the upstream orifice to develop this flow condition. It is also useful to print out the maximum and minimum orifice discharges. Repeat the analysis for a flow rate of 0.5 m^3/s to see how changing the rate affects the flow distribution. Comment on all relevant results.

Data:

Q_0 = 5.0 m^3/s; DIA = 2.0 m; F = 0.02; S = 3.0 m; N = 40;
allowable upstream head difference = 1.5 m.